FLUID FLOW MEASURING SYSTEM AND METHOD

BACKGROUND OF THE INVENTION

This invention relates to a totalized flow volume indication system and more particularly to such a totalized flow volume system for use with open flow channels having a known cross sectional configuration.

A flow meter for measuring flow in open channels utilizing the fluid surface height requires a non-linear converter to transform the height data. The non-linear relationship is a function of the configuration of the channel through which the fluid passes. Hydraulic equations exist for various types of weirs, flumes, and round pipe channels. In the past, conversions have been made using mechanical analog cams which have produced inaccuracies and which required a great variety of cams for each size and basic configuration of channel. There is a need for a system which measures flow volume in open channels by detecting and producing a signal related to the fluid surface height, eliminating mechanical flow computation devices, and by providing accurate flow rates for particular basic open channel cross section configurations by utilizing the signal related to surface height.

SUMMARY AND OBJECTS OF THE INVENTION

A total flow measuring system is provided which contains means for detecting a fluid surface level and for continuously generating a signal relative to a predetermined reference level. The detecting means also provides auxiliary outputs for visual indications of specific predetermined fluid surface levels of interest and for transmittal to devices which may perform certain operations on the flowing fluid dependent upon fluid surface level. The continuously generated fluid surface level signal is directed to a computer where it is transposed into a flow volume indication by a function read-only memory. Storage and maximum flow input register means combine to provide counts to a totalizer which indicates total flow volume through the channel.

In general, it is an object of the present invention to provide a total flow measuring system which converts fluid surface level to flow volume.

Another object of the invention is to provide a total flow measuring system which requires a minimum of different parts for different flow channel configurations.

Another object of the present invention is to provide a total flow measuring system with auxiliary outputs for performing specific operations on the flowing medium at predetermined fluid surface levels.

Another object of the present invention is to provide a total flow measuring system which will provide a continuous time display recording of flow volume.

Another object of the present invention is to provide a total flow measuring system which will generate a sampling signal at predetermined increments of flow volume.

Another object of the present invention is to provide a total flow measuring system which provides a cumulative total of flow volume.

Additional objects and features of the invention will appear from the following description in which the prefered embodiment has been set forth in detail in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front elevational view of a dam with a V-notch weir.

FIG. **2** is a side elevational view of the dam of FIG. **1**.

FIG. **3** is a sectional view through the center of an open channel.

FIG. **4** is a sectional view along the line **4—4** of FIG. **3**.

FIG. **5** is a schematic pictorial representation of the flow surface height detector and the flow volume computer.

FIG. **6** is a block diagram of the flow surface height transmitter and the flow volume computer.

FIG. **7** is an electrical schematic of the flow surface height transmitter.

FIG. **8** is an electrical schematic of the flow volume computer.

FIG. **9** is a timing diagram for the signals in the transmitter motor switching and time delay circuit.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The total flow measuring system and method described herein converts fluid surface height in an open channel to a flow volume through the utilization of a transfer function programmed into a read-only memory and associated adjustments to control signals related to other flow dimensions. Two situations may be noted as examples where the system disclosed herein may be used to measure flow volume. FIG. **1** shows a front elevational view of a dam **11** having a V-notch weir **12** formed in the top surface. A body of fluid **13**, water in this case, is shown in FIG. **2** having a free surface **14**. The surface **14** is above the lower extremity of weir **12** and an efflux **15** is seen passing through weir **12**. Relations for flow through weirs of various shapes as a function of height, $Q = Kf(H)$, are well known. The relation for flow through a V-notch weir is $Q = KH^{5/2}$. K is a constant of proportionality and H is the height of surface **14** above the lower extremity of weir **12**. The second situation illustrated is flow through an open channel having a specified shape in cross section such as the circular cross section channel **16** seen in FIG. **4**. The free surface **14** of the flowing fluid **13** as seen in FIG. **3** assumes the slope S of channel **16** which has a value defined by h/L for small slopes as noted. The hydraulic mean depth R of flow in open channels is defined as the ratio of cross sectional area A of the flow to wetted perimeter P of the flow channel. R therefore has a linear dimension and is obviously a function of H. The equation for velocity of flow in an open channel is $V = C\sqrt{RS}$. C is a dimensional coefficient depending on channel surface and cross section, and for steady uniform flow may be found through the empirical Manning equation $C = 1.49/n\ R^{1/6}$ n is a channel roughness factor which is available from tables, and is dependent upon the surface roughness characteristics of channel **16**. The basic flow formula $Q = AV$ when set out in terms of the foregoing produces:

$$Q = AC\ \sqrt{RS} = 1.49A/n\ R^{2/3}S^{1/2}$$

$$Q = (1.49)/(n)\ A^{5/3}S^{1/2}/P^{2/3}$$

When S is measured and combined with the quantity in brackets as K', the remaining terms are seen to be functions of H whereby: